Report for CO_SCIPO on Science policy models

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1. The birth of science policy

In November 1944, at the height of the Second World War, American President Franklin D. Roosevelt, aware of the ever-approaching victory of the United States and its allies, asked his scientific adviser, Vannevar Bush, a question that would mark the birth of science policy: how, Roosevelt asked Bush, could the government at the end of the war encourage scientific research to make the most of the effort made during the conflict and translate it in well-being for the nation? The answer was *Science – The Endless Frontier* (Bush, 1945; 1990), a seventy-page report, clear and direct, in which the brilliant engineer, mathematician, computer scientist, former vice president of the *Massachusetts Institute of Technology* and head of the *Office of Scientific Research and Development*, a structure that among other things supervised the Manhattan Project, outlined with a detail and determination never seen in the past the advantages of funding basic research.
It is a fundamental document. From it arose a broad theoretical debate regarding the presence and use of scientific knowledge in government activities in the aftermath of the fundamental contribution given by scientists to the success of the war.
The Endless Frontier marked the origin of a new disciplinary branch that will be called, precisely, science policy.

The expression is only imperfectly rendered in our language with the phrase "politics of science". It actually alludes to multiple issues related both to how the State regulates research funding and to how institutions use scientific data and knowledge to develop and justify public decisions, through which bodies and with what controls. It is above all of the most appropriate ways to use scientific knowledge within public life that a clear awareness has been and still is lacking in our country, despite the importance assumed by science and technology in law and politics (Tavernaro, 2021).

Science policy has remained the prevalent prerogative of the countries that have given public recognition to science more than others, in particular the Anglo-

Saxon ones. Already in the sixties of the last century, the American scholar Harvey Brooks emphasized the two aspects related to the increasingly important role that scientific knowledge had acquired for governments and the new political problems that this entailed. On the one hand, Brooks had indicated public interventions in support of research as policies for science. On the other hand, the author had indicated the growing presence of scientific knowledge within laws and public decisions as *science in policy,* science within policy decisions (Brooks, 1968). The clarification of the American scientist helped to systematize the discussion that emerged at the end of the Second World War on the establishment of the *National Science Foundation* (NSF), the main federal agency for funding basic research in the United States.

The need to create such a body was shared by the American political class of the time, but there were different opinions on how to get there. Opinions differed on the institutional structure of the NSF and the entities in charge of its *governance*. Between 1945 and 1950 – the year the agency was founded – the debate focused on two main perspectives of the relationship between science and politics.

On the one hand, there was the proposal of Vannevar Bush, representative of a liberal and liberal model of political control over science that wanted to guarantee a solid base of research funding but at the same time save the traditional autonomy of scientists in setting their own agenda. "Scientific progress in the broad sense arises from the free play of free intellects that choose to explore the unknown following the sole dictates of their own curiosity" wrote Bush in his manifesto (Bush, 1945; 1990, p.12).
On the other hand, a different program put forward by Democratic Senator Harley M. Kilgore and John R. Steelman, chairman of the *Scientific Research Board*, in the paper *Science and Public Policy* (Steelman, 1947; 1980), commissioned by President Truman shortly after the publication of The Endless Frontier.

Although determined to boost research, Truman opposed Bush's model because it lacked effective democratic control over scientists, who presented themselves as a committee of private citizens who enjoyed federal funding. In Bush's liberal-conservative vision, science had to be preserved from any political interference, considered an attack on intellectual freedom and scientific success itself. Opponents of this approach considered the proposal to remove the organization of science from the traditional guarantees of power profoundly undemocratic. The Steelman report emphasized a point that has remained essential today: science is a power and in democratic societies all power is limited and subject to control. Although systematic support for scientific activities introduced an unprecedented novelty, according to Steelman there was nothing in science that justified a departure from the traditional principles of operation of democratic institutions (Steelman, 1947; 1980, p.31), including the principles of accreditation and prevention of possible hegemonic concentrations.

In the founding act of the National Science Foundation by the American Congress in 1950[1] , an attempt was made to combine the two positions, which have marked the development of science policy all over the world and which have been marked by a strange fate.

In fact, if the well-known Bush Report was considered the first document to have explicitly posed the problem of the relationship between science and politics (Greco, 2013), it was the less famous and cited Steelman Report that actually influenced the subsequent debate on the relationship between science and democracy.
It still retains elements of topicality, because while the Bush report completely absent the awareness of the reciprocity between science and politics, the Steelman report captures it perfectly: the activities of researchers are part of public life and therefore are a political topic. In Science and Public Policy there is full awareness of the continuous shifts between the language of science and the normative languages of law and politics, between what constitutes a fact and what is considered a value judgment.

As David Guston has observed, the Bush and Steelman reports open, in the contemporary age, the problem of the social contract with science regarding the delegation of power that society makes with respect to a very authoritative knowledge (Guston, 2000).

2. The modern model: *science speaks truth to power*

As we have seen, with the end of the Second World War, science acquires an organic place within democratic societies and institutions, but its relations with politics and law date back much earlier. Since the origins of the modern State, political-legal knowledge and practices had in fact already looked at science for a long time as a methodological model to which they could try to approach in order to overcome their traditional lack of certainty and objectivity (Price, 1965).

It is to the European Enlightenment that we must refer above all in order to understand the conceptual bases of the science policy developed from the second half of the twentieth century. In the culture of the Enlightenment, the relationship between science and politics, at least on paper, is very simple: scientists are in charge of producing facts, objective and reliable knowledge, while it is up to citizens and their representatives to choose the goals to be pursued on the basis of values and preferences. The authority of scientists depends on their ability to produce unambiguous opinions based on neutral results. In other words, there is a clear boundary between science and politics.

[1] National Science Foundation Act of 1950, Public Law 81-507, May 10 (64 Stat.149): Section 4 (42 U.S.C. 183).

In the Enlightenment vision of the modern State based on the provision of certain and rational rules desired by the legislator, the scientific method is the ideal to refer to in order to produce universally valid knowledge.
The image of a completely certain science to be inspired by has retained a certain strength to the present day, despite the fact that over the years the examples of unpredictability of results and the inability to control increasing complexity have multiplied.

Significant proof of this fact was in our country in April 2020, in full lockdown. In a statement released to " theCorriere della Sera", the then Minister for Regional Affairs and Autonomies Francesco Boccia, when asked if Italy was far behind with the tests, replied: "I ask the scientific community, without controversy, to give us irrefutable certainties and not three or four options for each issue. Can those who have already had the virus catch it? There is no answer. The same applies to serological tests. We demand clarity, otherwise there is no science. We politicians take responsibility for deciding, but scientists must put us in a position to do so. We cannot stand still until the vaccine arrives," the minister commented (Guerzoni, 2020).
Boccia's words resonate with the consolidated technocratic expectation we mentioned above: that of easily translating scientific knowledge into public measures, of having "irrefutable" statements at one's disposal. A request, that of the minister, which sounds even more out of tune today, especially in the part that foreshadowed an easy exit from the emergency thanks to vaccines alone.

The Italian politician's statements are also emblematic when compared with the answers given at the end of January 2020 by Anthony Fauci, the White House's super adviser on the Covid pandemic, to journalists who asked him for clarification on various aspects of the virus. To confirm that the approach to scientific advice based on "certainty" is not the only possible one, the American immunologist known for his contributions to AIDS research but who has become a world celebrity for his controversial relationship with President Trump, said: *we don't know*, there are still many unknown[2] aspects.

There is a lot of difference with respect to Boccia's claims. If it is true that probably the requests of the Apulian parliamentarian also hid the need to offload the responsibility for difficult choices, they evoked a vision of the scientific enterprise of nineteenth-century memory capable of producing indisputable results, not an activity in the continuous search for hypotheses and correlations between phenomena, as Fauci's words more realistically suggested. Conversely, in this, as in other similar cases in the history of Italian politics (Pace, 1997), the lack of unambiguous knowledge was associated with a condition of anarchy.

However, as we have said on several occasions, uncertainty is by no means arbitrary and does not justify arbitrary political decisions. On the contrary, the

[2] White House coronavirus task force holds briefing amid outbreak, 1/31/2020, Jan 31, 2020, 4:15 pm, https://www.youtube.com/watch?v=ywiLsZZdX5A (last accessed 19 December 2021).

explanation of undefined aspects, a more reasoned dialogue between citizens, scientists and institutions, the juxtaposition of disciplines with different views on reality, the explicitness of the fact that scientific evidence can be weak or strong, are all elements that contribute to making decisions more legitimate, robust, reliable.

Silvio Funtowicz has called the epistemological perspective of certain objectivity and reciprocal neutrality between science, politics and law a "modern model". The name refers to an old-positivistic conception of the use of science for public choices (Funtowicz, 2010). The American political scientist Aaron Wildavsky summarized this vision with the famous, icastic expression *science speaks truth to power*: science, one, certain and objective, offers truth to power (Wildavsky, 1979).

In the modern model, the foundation of the "truth" that science communicates to regulatory systems concerns both the validity of knowledge and the moral credibility of scientists, connected to the ethics within the scientific community. The rationality of science behind the models of liberal-democratic society also consists in emphasizing the predictive capacity of science with respect to the evolution of the phenomena it interprets. Hence its reliability also for legal and political choices. From this perspective derives the idea that the laws of the State are not subject to expiration in themselves. As Funtowicz always reiterates: "If the principle of action underlying the modern State, with its focus on risk and responsibility, consists in believing that the prediction of the future is necessary to act in the present, then it is necessary to identify a principle of legitimization of public action" (Funtowicz, 2010, p.536).

The basic orientation of this conception is largely technocratic. Even where power is not handed over to experts, there is a kind of implicit delegation of "ir-responsibility" to scientific knowledge. Scientists are not held responsible because their thinking corresponds to the truth of science and not to individual judgment. Politics, therefore, must not really choose but simply implement the evidence it is facing.

As an example of how current the use of this delegation of responsibility is in Italian politics, but not only, it is enough to recall the words in the dark days of the 2020 lockdown of the then Prime Minister Giuseppe Conte, who every day, like a mantra, to legitimize government action repeated: "let's do what scientists tell us". A statement that on the one hand made the political decision unproblematic, on the other tried to separate neutral scientific knowledge from the responsibilities of choice. We have also seen similar scenarios, with the consequent accusations of "health dictatorship", reproduced in many other countries (Carney, 2021), proving that the modern model, despite its limitations, continues to enjoy a strong capacity for attraction towards politics even across borders.

However, its cracks are not always containable and for this reason over the years several variants have been developed in an attempt to repair the most obvious defects. One of these consists in a sort of "pre-packaging" of the available science, that is, in presenting an apparently single option of choice when in reality the alternatives in the field are many.

3 Prefabricated science

Sometimes science *speaks truth* after power *speaks decisions*, i.e. scientific confirmation is asked to support a decision already made. Other times, the endorsement of experts is sought in the presence of a direct negotiation of relevant facts and values. In the first months of the Covid crisis, for example, masks were not available and the guidelines set by the World Health Organization prescribed their uselessness for those who did not have symptoms. The rule was justified by national and international scientific committees with the lack of evidence that masks effectively protected against infection.
These choices are attributable to attempts to evade the less credible aspects of the modern model, which have become evident on divisive issues, such as biotechnology or certain bioethical issues. These are adjustment maneuvers aimed at building a univocal scientific opinion that legitimizes the directions desired by the political decision-maker. They consist either in the *ad hoc* identification of the skills necessary to define a problem, for example by excluding from an expert committee knowledge that may be problematic, or in the direct identification of scientists with known and predictable positions.
Pre-establishing which disciplines and knowledge are relevant to developing the desired discussion framework is a technique for reducing complexity and uncertainty called *pre-cooking expertise*. This expression refers to the "framing model" introduced by Funtowicz (2010, p. 543) to indicate the preventive construction of the interpretative framework of a problem.
An example of the pre-packaging of scientific judgment through the selection in advance of the relevant skills and of the representatives of the disciplines themselves (Larsson, 2003) is what happened in 2000 in Italy with the Dulbecco Commission on stem cells[3].
The line of research indicated by the wise men consulted by the then Minister of Health Umberto Veronesi had in fact been foreseen and pre-established. It was based on the insertion of an adult cell nucleus taken from the patient into an oocyte without a nucleus and therefore without the formation of the embryo. In this way, the ethical problems that would have prevented a compromise between opposing political positions (Catholic and secular) on the issue were circumvented. A similar case can be found in the same years in the United States, where William Hurlbut, a Stanford neurobiologist and advisor to President George Bush, had proposed the possibility of developing embryo-like embryos without the potential for development. Not having a full human status, the so-called blastoids would not have met resistance from religious faiths (Check, 2005).

[3] See the report of the study commission on the use of stem cells for therapeutic purposes of 28 December 2000 available at web https://www.istitutobioetica.it/187-documenti/593-relazione-della-commissione-dulbecco-sulle-cellule-staminali (last accessed 20 December 2021).

In both cases, not only was the scientific judgment already clearly oriented towards the policy directions to be pursued, but the proposed technologies had been chosen because they were flexible, i.e. able to overcome any ethical resistance.

Even more exemplary in the field of pre-cooking expertise is the story of xenotransplantation, the biomedical technology that is still very experimental based on the use of animal cells and tissues in humans. This is a research area developed to remedy the scarcity of organ donations that since its inception has encountered numerous technical difficulties and ethical objections.
Xenotransplantation is very problematic due to the risk of generating a jump of pathogen species from non-human animals to humans. The danger is to unleash new and perhaps unknown forms of zoonoses with pandemic potential (Tallacchini, 2017b). In order to overcome regulatory barriers, American regulatory agencies assumed in the early 2000s as a basic hypothesis that the possible risk of zoonoses was similar to that generated by HIV, a fearsome disease that could be controlled through responsible individual conduct (Public Health Service, 2001). In addition, the control bodies implicitly ruled out that the contagion could spread by air, in a similar way to Sars-Cov 2, a possibility that would have made the experimentation even more problematic, if not completely unacceptable. Also in this example, American policymakers chose the science most convenient to their goals and completely left out perspectives that would have hindered the continuation of research.
Very different were the considerations on the same subject of the European institutions and in particular of the Council of Europe, responsible for the field of human rights in the biomedical field. Unlike the Americans, European experts accepted the hypothesis of an airborne zoonosis and as a demonstration of how delicate the issue was, the decision led to justify the forced isolation and "legitimate detention" of patients undergoing xenotransplantation (Council of Europe, 2003). The Commission of the European Community on Health and Consumer Protection also agreed on this point, according to which, since xenotransplantation could have implications for everyone's health, "patients (and others?) should therefore allow the renunciation of some fundamental human rights" (Commission of the European Communities, 2001a).

Words that, on the one hand, give a good idea of how the vision of public health has changed today, and on the other hand reveal how prefabricated choices can lead to very different outcomes.

4 Demarcation: Purifying Facts from Values

A further variant of the modern model consists in considering the function of scientific advice as informative and not prescriptive. That is, experts make themselves available to assess the solidity of the specialized literature and provide their opinions on the matter but refrain from expressing an opinion on the policies to be followed, they never impose what to do. The demarcation model reproduces the widespread belief that science should only deal with facts and

that these are clearly distinguishable from interests, ideologies, social or cultural aspects.
In the previous chapter we saw that values can actually play a significant role in the production of knowledge, but, despite this, the vision of a clear boundary between science and the rest of society continues to have institutional success.

One of the most historically important examples of this idea can be found in the field of risk management, with the publication in 1983 in the United States of a study by the *National Research Council* [ref.] commonly known as *Red Book*. The document had a strong influence all over the world: it was aimed at assessing the risk of cancer in exposure to toxic substances, theorizing the separation of the "analytical function of defining risk" from the "regulatory function of policy". The two categories of *risk assessment* and *risk management were thus defined*: the first conceived as a process free from social objectives, the second responsible for establishing the level of protection for specific segments of exposed populations and other social choices (NRC, 1983).
The assumption of separating the judgments of scientists from the many forms of evaluations that run through them soon proved to be a theoretical aspiration. It was immediately clear that there was no empirical evidence capable of resolving ethical and discretionary questions.
The attempts of American politics to isolate factual knowledge from risk assessments clashed starting with the Red Book, so in reality with a continuous reshuffling of risk assessment and risk management [ref.]. Such contamination, however, may prove desirable, since the adequate identification of the facts by scientists must correlate with the identification of the aims that the political decision-maker is pursuing, at least to allow a delimitation of the field of scientific investigation, including the need to clarify what risks are to be identified.

In the modern model and its variants, certainty and objectivity of knowledge are never questioned: the main objective remains in fact to define procedures capable of providing unambiguous results.
As we have seen, this ideal requires ad hoc adjustments, often perceptible to citizens, which actually turn out to be a weak point for the model itself. Once uncertainty becomes visible, or there is a lack of data for a comprehensive risk assessment, transparency defects at the interface between institutions and society turn into a boomerang.
The lack of clarity on the composition and procedures for appointing technical committees, on how to choose experts and the knowledge they represent, on the reasons for choosing a specific scientific judgment and on how to access opinions, undermines the building of trust between politicians, scientists and citizens.

For this reason, we believe that the attempt to maintain a naively positivist vision of science is not credible in itself and is not practicable in technologically advanced democracies. Only the full recognition of uncertainty, of science as probability, with margins of error and reliability on a scale of continuity, can be the starting point for a way of using scientific knowledge capable of appearing fully reliable.

5 The European way to science policy: the precautionary principle

Despite the deference with which Europe has long looked at science and research policies in the United States, the old continent had to develop its own model of science policy at some point for historical and political reasons. Since the end of the last millennium, European institutions have tried to innovate the way of understanding the relationship between science, institutions and civil society not only to create fairly homogeneous and standardized decision-making processes in scientific-technological issues characterized by high uncertainty, but also to distinguish themselves from the Anglo-American models.

The characteristic feature of science policy and law in Europe over time has been defined along two lines: the constant desire to integrate science and values and respect, in line with the concept of subsidiarity, for the ethical choices of each legal system of the Member States.

The resulting science policy model has established itself internationally as a symbol of environmental protection and, despite many ambiguities, of the European regulation of technological innovation. Its peculiar feature is the precautionary principle which, from the directives on biotechnology to the provisions for adverse reactions to anti-Covid vaccines, has represented a very particular way of responding to scientific uncertainty.

The precautionary approach is established in the context of international environmental protection as a response to possible risks of serious and irreversible damage in which the "lack of full scientific certainty" must not be used as a reason for delaying the use of preventive measures (Rio de Janeiro Declaration, Principle 15).[4]

The European Commission, and subsequently the Treaty on the Functioning of the European Union, have transformed these assumptions into one of the founding principles of the Union itself.

In 2000, a Commission Communication defined as a precise responsibility, not scientific but political, the preventive protection of animal, human and plant health in the face of the existence of a potential risk of harm, even if the evidence is not entirely conclusive (European Commission, 2020). Faced with different risk scenarios, the legislator or the political decision-maker must therefore tend to adopt the scientific perspective that best protects citizens, i.e. preferring decisions that generate false positives (conditions of potential risk that then do not come true), rather than false negatives (neglected risks that then turn out to be real).

The basis of the precaution is that Europe considers little-known and unquantifiable risks as more worrying risks. The attitude is opposite to the more traditional position of US regulation, which tends to consider non-quantifiable risks

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[4] United Nations Conference on Environment and Development, Rio Declaration on Environment and Development, A/CONF.151/26 (Rio de Janeiro, 3-14 June 1992), Principle 15: «In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation».

as non-risks. The English expressions to indicate these two opposite ways of dealing with uncertainty are, respectively, *policy-related science* and *science-based policy*. While the European Union chooses the science that best suits the high level of social security adopted by European countries, the United States builds the policy on the evidence already validated and quantified by science.
The precautionary principle has deeply divided the two sides of the Atlantic on the subject of genetically modified organisms (GMOs). This opposition resulted, in 2003, in a legal dispute before the WTO, the World Trade Organization. The case saw the position of the United States prevail – and the EU did not challenge the decision – which saw, behind the precautionary principle, a mere form of economic protectionism with which Europe wanted to prevent the import of genetically modified products from the United States (Winickoff et al., 2005).
This attitude of openness to the possible risks produced by technological innovation and the concept of *science-based policy* remain central to the governance of research and the regulation of American science. The United States, for example, has always opposed the labeling of GMOs itself, considering the safety judgment provided by scientists sufficient. As mentioned above, the Americans continued the xenotransplant experiment when many European countries had evoked the moratorium. In recent times, this approach has been confirmed with regard to the problems of artificial intelligence, with respect to which US regulators have decided to focus on the *self-regulation* of companies [ref.].
However, a different path has been followed on the public health front with regard to Covid-19. Anthony Fauci's repeated and already recalled *we don't know* have marked, if not a retreat, at least the search for a new point of balance between the rejection of the precautionary principle and European paternalism. In the admission of ignorance of the American immunologist we must not find a change in the general point of view, but rather a profound awareness of a shortcoming. Fauci wanted to communicate the fact that we were not facing a potential risk that had not yet occurred: it is that we just didn't know. And consequently he turned to political power.
In an ironic reversal of points of view, we could say that the American superconsultant has become the spokesman for a science that *speaks uncertainty to power*. Fauci did not pretend to decide for politicians. In line with legal systems that rely heavily on self-regulation and self-limitation of behavior, he called on everyone to be responsible and to try to govern the pandemic he proposed a pragmatic mix of patience, prudence and promptness, not non-negotiable prescriptions.

The story testifies to how complex the impact of legal traditions is on the relationship between knowledge, the precautionary principle and public decisions. Still on the subject of anti-Covid vaccines, the decisions that led in several European countries, including ours, to the temporary suspension of AstraZeneca inoculations have been labeled by the media as excesses in the use of the precautionary principle. In reality, they corresponded exactly to the idea of precaution as a political (responsibility) choice. It is true that each country has acted differently, but this has happened both in accordance with what has been authorized by *the European Medicines Agency* (EMA) and with what is known as the principle of subsidiarity, i.e. the possibility for EU member countries to deviate their ethical assessments from a possible (and in this case missing) European standard. That the precautionary attitude was not excessive was then found in fact: the vaccine has never been approved in the United States also for reasons related to its efficacy and safety. It is no coincidence, then, that almost all European countries have, rather silently, abandoned it.

The precautionary principle has been criticized by many because it is opaque, disrespectful of science and prone to the irrationality of the public. These criticisms have led to a more pluralistic and participatory rethinking of the precautionary measure to strengthen citizens' trust and to respond more effectively to crisis situations, such as the two emergencies in the food security sectors that shook European countries at the end of the last century, triggering many doubts about the ability of institutions to control: the scandal of dioxin in chickens and eggs broke out in Belgium in 1999, and the case of bovine spongiform encephalopathy in Great Britain starting in 1996.

The repetition of events in which experts appeared unable to dominate situations of scientific uncertainty and in which, at times, errors of assessment or interests in contrast with the safety and health of citizens emerged, have made the problem of civil society's trust in science, where it is directly involved in public decisions, crucial.

Mariya Gabriel, European Commissioner for Innovation, Research, Culture, Education and Youth, commenting on the results of one of the latest Eurobarometer surveys on the relationship between science and society, said: "We are reassured to see a globally positive attitude towards science and technology, as they are indispensable to respond to the coronavirus. climate change, biodiversity loss and a whole host of other pressing challenges. At the same time, we need to respond to citizens concerned that the benefits of science and technology are not equally distributed, pay more attention to the gender dimension in research content, and reflect on ways in which citizens and other stakeholders can be more involved in research and innovation activities."[5]

The Commissioner's words are the result of a process of recognition of its mistakes by Europe, which in recent decades has launched several plans to bring science and scientists closer to society, characterized, among other things, by significant terminological deviations: from the increase in "public awareness" we have moved on to talk about "science and society", then "science in society" and finally "science with and for society".
In concrete terms, these actions aimed at paying greater attention to gender issues and the role of young people, improving communication between citizens and scientists in the sense of listening to each other, and introducing the concept

[5] Text taken from a press release of 23 September 2021 by the European Commission entitled: New Eurobarometer survey: Europeans are clearly on the side of science and technology, https://ec.europa.eu/commission/presscorner/detail/it/IP_21_4645 (last accessed 20 December 2021).

of responsible research and innovation, according to which scientists should take into account and be held accountable for all the consequences of their research activities (von Schomberg, 2010).

This dialogic process between institutions, scientists and citizens has also translated into more inclusive and plural ways of institutional acquisition of knowledge. As a communication from the Commission of the European Communities at the beginning of the 2000s reiterated, one criterion "on the basis of which quality is determined is pluralism. Whenever possible, it is desirable to gather a variety of opinions. Such variety may arise from different scientific approaches, different types of specialist knowledge, different institutional affiliations or conflicting views on the fundamental assumptions regarding the issue under consideration. Depending on the topic and the stage of the political cycle, pluralism also means taking into account multidisciplinary and multi-sectoral advice, as well as minority and counter-current opinions. Other factors can also be important, such as geographical, cultural and gender factors" (Commission of the European Communities, 2002, p. 9).

6 Democratizing science

According to Silvio Funtowicz, the precautionary model does not introduce a real break with the modern model, in the sense that both remain united by the desire to reduce complexity and uncertainty (Funtowicz, 2010, p.545). The precaution is limited to assigning the responsibility of choosing between different scientific scenarios to the political decision-maker, instructing him to paternalistically protect citizens. The real discontinuities that embrace the most radical and uncontrollable aspects of uncertainty emerge in the description of post-normal science described in the previous chapter.

In terms of the relationship between science, politics and citizens, the load of unpredictable or uncontrollable risks lucidly focused on by Funtowicz and Ravetz translates into the need to expand the audience of creators and reviewers of knowledge to support public decisions.
In particular, the "clear division between scientists — disinterested and willing to self-criticism within a Mertonian academic system — and civil society which, implicitly, cannot be recognized as critical competences" (Funtowicz, 2010, p.546) is modified. The change in perspective regarding the dividing line between experts and non-experts produces an extension of the peer community, which is no longer composed only of scientists, because any relevant knowledge, coming from many parts of society, can contribute to the process of certifying the quality of science.
The so-called extended participation model of knowledge implies what the European institutions themselves have called the "democratization of science", understood both as a democratization of scientific *expertise* (Commission of the European Communities, 2021b), and as a more robust participation of citizens in public decisions (Commission of the European Communities, 2021c). In other words, on the one hand the forms of knowledge that underpin decisions are

expanded, on the other hand there is a rethinking of the functioning of institutions in the use of relevant knowledge (Liberatore, Funtowicz, 2003). Citizens become active in the production of new knowledge and a plurality of legitimate and coordinated perspectives is accepted, each with its own interests and reference values.
A democratic society of knowledge (Pitrelli, Tallacchini, 2021) conceived in this way is a "democracy of experience", which proceeds by testing itself through knowledge co-produced by an extended community of experts and reviewers (*extended peer-review*) made up of institutions, scientists and citizens.

7 Conclusions

What is the "rightful place of science" in society? The so-called modern model of science, which places itself univocally and univocally in power, has been followed by several variants designed to try to overcome its limits and defects, without ever questioning the objectivity and certainty of scientific knowledge. The divisions in disciplinary communities and the multiple forms of uncertainty in the production of knowledge, however, were no longer retractable at a certain point with simple adjustments. In addition to these aspects, the progressive awareness of irreparable ecosystem damage has led to the formulation in Europe of the precautionary principle, a synthesis of a different sensitivity of the old continent compared to the United States, of the relationship between science and politics. It declares the decisive shift of the responsibility to choose between different scientific options to the political decision-maker, who can no longer limit himself to acquiring and ratifying scientific evidence.
But the real detachment from the modern model occurs when policy makers recognize the multiplication of sources of knowledge production and the need to make citizens participate in the knowledge that can legitimately inform regulatory choices. The democratization of science understood in this way opens up new spaces and procedures for transparent sharing of decisions even if, in practice, however, the infrastructures for the open acquisition of notions, concepts or practices necessary to implement it are still lacking.

In rethinking the rightful place of science in society, science policy scholar Sheila Jasanoff, professor at Harvard's Kennedy School of Government and one of the world's leading authorities on science and technology studies, has observed that the sound of science and democracy are based on the same values: fidelity to reason and argumentation; transparency on the criteria of judgment and decision; openness to criticism; skepticism with respect to the dominant but undisputed values; willingness to give space to dissenting voices, evaluating their validity; willingness to acknowledge uncertainties; critical attitude towards the undisputed authorities; attention to problems of legitimacy and justice; equity in communication.
"In rejecting the 'special character of science' and in accepting the essential parallelism between learning science and democracy, science," Jasanoff asserted, "will find its rightful place" (Jasanoff, 2009).

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